Title: Insulation Times Three

Brief Overview:

Students will use temperature probes and the TI-83 Graphing Calculator in conjunction with CBL units to test insulation properties of various materials. They will test the rate of cooling or containers made of styrofoam, glass, and metal.

Links to NCTM Standards:

- **Mathematics as Problem Solving**
  Students will demonstrate their ability to solve mathematical problems through the use of experimentation. They will use different forms of insulation to determine the best insulators and how they relate to temperature change.

- **Mathematics as Reasoning**
  Students will investigate and determine what materials constitute the best insulators.

- **Statistics**
  Students will learn to use statistical plots and develop regression equations.

Grade/Level:

Grades 9-12

Duration/Length:

This activity will take one class period. Follow up time should be allowed to discuss outcomes.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- TI-83 Graphing Calculator
- CBL Unit and graphing background
- Measuring skills
- Statistics

Objectives:

Students will be able to:

- collect and organize data.
- evaluate statistical data to compare qualities of insulation materials.
- analyze statistical data.

Materials/Resources/Printed Materials:

- TI-83 Graphing Calculator
- CBL Unit
- Three cups (styrofoam, glass, metal)
- Graph Link
- Three Temperature Probes
- "Insulate" Program

Development/Procedures:

- Group students in pairs.
- Provide groups with the following:
  1) TI-83 Graphing Calculator
  2) CBL Unit
  3) Three Temp Probes
  4) Graph Link
  5) Three cups of different insulating materials
  6) "Insulate" Program for the TI-83
  7) Hot Water
- Direct groups to utilize Figure 1 in the experiment set-up.
- Instruct groups that they will be required to submit a written analysis of their experiment in support of their conclusions.
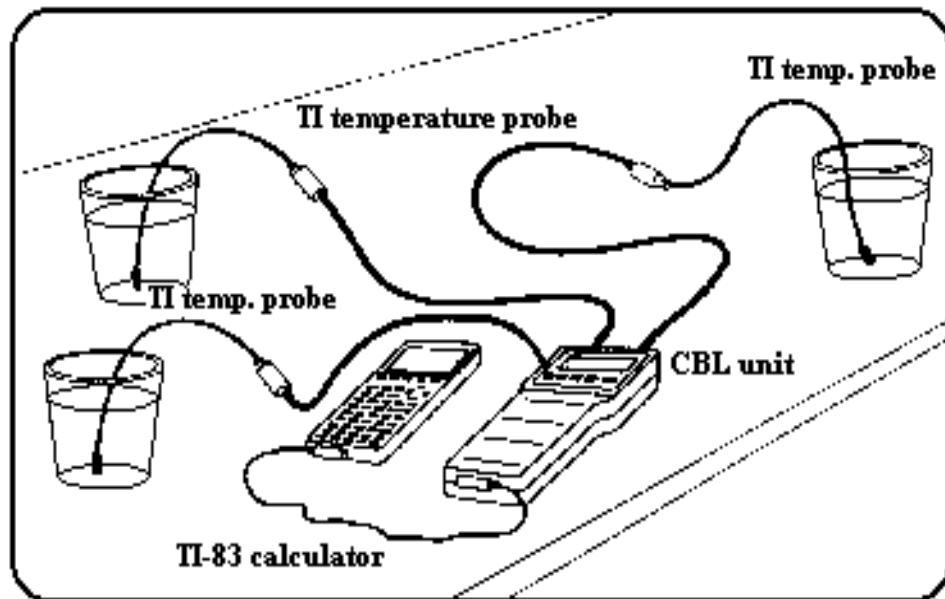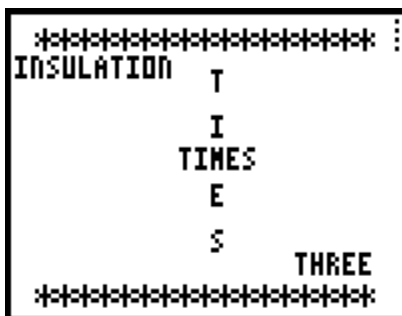
Student Activity

Figure 1

Experiment Set-Up

1. Obtain three different containers of equal capacity and different insulating materials.
2. Connect a TI-83 to the CBL Unit (see figure 1).
3. Turn on the TI-83 and the CBL Unit.
    Access the program "INSULATE" on the TI-83.

1. Activate the program by pressing   "ENTER".
2. Follow the instructions on the TI-83 screen to complete the activity.

Activity Data:

1. Link the TI-83 to the computer to produce
   hard copies of graphs A, B, and C.
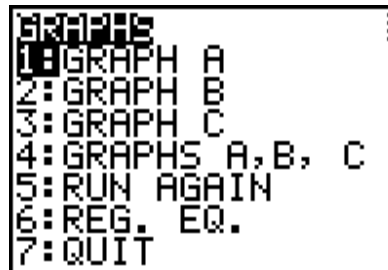
2. Label each graph according to the material used in the container.

3. Using the data from graphs A, B, and C rank the containers.

_____

4. From the data collected, what conclusions can be drawn?

_____

_____

Extension:

1. Continue the program by pressing "ENTER" and access the regression equation menu.

2. Link the TI-83 with the computer to produce hard copies of graphs

    "REG EQ" A, B, and C.

```
REG. EQ.          ⋮
1:GRAPH A
2:GRAPH B
3:GRAPH C
4:GRAPH MENU
5:QUIT
```
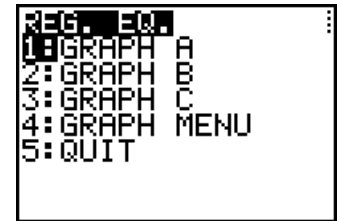
3. Activate Y= and turn on Y_1, Y_2, and Y_3.

4. Graph the equations simultaneously.

5. Does the mathematical model support your conclusions? Explain.

Evaluation:

The student will submit to the instructor a computer generated print out of the rate of cooling graphs. The student will also submit a written analysis of their experiment in support of their conclusions. A rubric is to be developed by the class and the instructor for scoring. It is suggested that a four-point rubric be developed where a score of four can only be obtained if the extensions are completed.

Extension/Follow Up:

- Utilize different materials.
- Reverse procedure and investigate warming properties.
- Investigate conductivity.

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Insulation Times Three
Developed By
Michael W Stover and Alex J Mastroianni


```
FnOff
PlotsOff
AxesOff
ClrDraw
ClrHome
Disp "  DESIGNED BY"
Disp "        "
Disp " MICHAEL STOVER"
Disp "        "
Disp "      AND"
Disp "        "
Disp "ALEX MASTROIANNI"
Pause
ClrDraw
ClrHome
Text(5,5,"INSULATION")
Text(50,70,"THREE")
For(I,1,99,1)
For(I,5,50,5)
Text(I-5,5,"                    ")
Text(I,5,"INSULATION")
Text(60-I,70,"                 ")
Text(55-I,70,"THREE")
For(D,1,99,1):End
End
Text(50,5,"INSULATION")
Text(5,70,"THREE")
For(I,1,99,1)
For(I,2,50,4)
Text(50,I,"           ")
Text(50,I+5,"INSULATION")
Text(5,70-I,"                 ")
Text(5,56-I,"THREE")
For(D,1,99,1):End
End
Text(50,55,"INSULATION")
Text(5,6,"THREE")
For(I,1,99,1)
For(I,5,45,5)
Text(56-I,55,"                      ")
```

```
Text(51-I,55,"INSULATION")
Text(I-1,6,"                      ")
Text(I+5,6,"THREE")
For(D,1,99,1):End
End
Text(7,55,"INSULATION")
Text(50,6,"THREE")
For(I,1,99,1)
For(I,5,50,5)
Text(7,55-I,"                        ")
Text(7,50-I,"INSULATION")
Text(50,I,"                 ")
Text(50,20+I,"THREE")
For(D,1,99,1):End
End
For(I,1,99,1)
For(I,5,85,5)
Text(1,I,"*")
Text(57,90-I,"*")
For(D,1,99,1):End
End

For(I,1,99,1)
For(I,15,45,5)
Text(I-5,58,"        ")
Text(I,58,"S")
For(D,1,99,1):End
End
Text(45,58,"S")
For(I,1,99,1)
For(I,1,10,2)
Text(45,60-I,"    ")
Text(45,58-I,"S")
For(D,1,99,1):End
End
Text(45,42,"T")
For(I,1,99,1)
For(I,5,40,5)
Text(55-I,42,"     ")
Text(50-I,42,"T")
For(D,1,99,1):End
End
Text(10,42,"T")
For(I,1,99,1)
For(I,1,8,2)
```

```
Text(10,40+I,"     ")
Text(10,42+I,"T")
For(D,1,99,1):End
End
Text(10,58,"E")
For(I,1,99,1)
For(I,15,35,5)
Text(I-5,58,"          ")
Text(I,58,"E")
For(D,1,99,1):End
End
Text(35,58,"E")
For(I,1,99,1)
For(I,1,10,2)
Text(35,60-I,"          ")
Text(35,58-I,"E")
For(D,1,99,1):End
End
Text(45,42,"I")
For(I,1,99,1)
For(I,5,30,5)
Text(55-I,42,"     ")
Text(50-I,42,"I")
For(D,1,99,1):End
End
Text(20,42,"I")
For(I,1,99,1)
For(I,1,8,2)
Text(20,40+I,"     ")
Text(20,42+I,"I")
For(D,1,99,1):End
End
Text(27,5,"TIM")
For(I,1,99,1)
For(I,5,35,5)
Text(27,I,"      ")
Text(27,6+I,"TIM")
For(D,1,99,1):End
End
Text(27,80,"ES")
For(I,1,99,1)
For(I,10,20,5)
Text(27,80-I,"              ")
Text(27,73-I,"ES")
For(D,1,99,1):End
```

```
End
Pause
Lbl N
AxesOff
ClrDraw
ClrHome
Menu("DIRECTIONS","YES",I,"NO",J,"PREVIEW",B,"RECOVER",G)
Lbl I
ClrHome
ClrDraw
FnOff
ClrHome
ClrDraw
PlotsOff
ZStandard
Dot
DrawF ð(5-(X-6.5)Ü)+1.5
DrawF úð(5-(X-6.5)Ü)+1.5
DrawF ð(5-XÜ)+1.5
DrawF úð(5-XÜ)+1.5
DrawF ð(5-(X+6.5)Ü)+1.5
DrawF úð(5-(X+6.5)Ü)+1.5
DrawF úð(1-(X-6.5)Ü)-5
DrawF úð(1-(XÜ))-5
DrawF úð(1-(X+6.5)Ü)-5
Line(8.72,1.26,7.45,ú5.32)
Line(2.13,.81,.85,ú5.53)
Line(4.5,.57,5.53,ú5.25)
Line(ú2.13,.81,ú.85,ú5.53)
Line(ú4.47,.57,ú5.53,ú5.25)
Line(ú8.72,1.26,ú7.45,ú5.32)
Text(37,15,"A")
Text(37,46,"B")
Text(37,76,"C")
Text(2,5,"FILL  THREE  CUPS  WITH  =")
Text(8,5,"AMOUNTS  OF  HOT  WATER")
Text(53,25,"[PRESS  ENTER]")
Pause
Disp "  CONNECT THREE"
Disp "   TEMPERATURE"
Disp "   PROBES INTO"
Disp " CHANNELS 1,2,3"
Disp "          "
Disp "          "
Disp ("  [PRESS ENTER]")
```

```
Pause
ClrDraw
ClrHome
Disp "PLACE EACH PROBE"
Disp " INTO A CUP OF"
Disp "  HOT WATER"
Disp "        "
Disp "        "
Disp " [PRESS ENTER]"
Pause
ClrHome
ClrDraw
Disp "        "
Disp "        "
Disp "WAIT 60 SECONDS"
Disp "        "
Disp "        "
Disp " [PRESS ENTER]"
Pause
Lbl 5
ClrHome
Disp "ENTER THE NUMBER"
Disp "OF SECONDS BET."
Disp "READINGS (T)"
Disp "   "
Prompt T
ClrHome
ClrDraw
Disp "  "
Disp "ENTER THE NUMBER"
Disp "OF READINGS TO"
Disp "BE TAKEN (N)"
Prompt N
(T*N)/60üW
iPart(W)üW
ClrHome
ClrHome
ClrDraw
Disp " THIS PROGRAM"
Disp " WILL TAKE A"
Disp " READING EVERY"
Output(4,4,T)
Output(4,8,"SECONDS")
Output(5,8,"FOR")
Output(6,4,W)
```

```
Output(6,8,"MINUTES")
Output(8,3,"PUSH [ENTER]")
Pause

Menu("SETTINGS","CHANGE SETTINGS",5,"CONTINUE",6)
Lbl 6
ClrHome
ClrDraw
Lbl J
ClrDraw
ClrHome
Disp "        "
Disp "        "
Disp " PRESS ENTER TO"
Disp " TO RUN PROGRAM"
Disp "  THE CBL WILL"
Disp "    FLATLINE"
Disp "        "
Disp "  [PRESS ENTER]"
Pause
Goto E
Lbl E
ClrDraw
ClrHome
AxesOn
PlotsOff
Send({1,0})
Send({1,1,11,0,0,0})
Send({1,2,11,0,0,0})
Send({1,3,11,0,0,0})
Send({3,T,N,0,0,0,0,0,1,0})
ú2üXmin
dim(Lƒ)+4üXmax
1üXscl
ú2üYmin
max(L•)+4üYmax
1üYscl
ClrHome
Disp "        "
Disp "        "
Disp "        "
Disp "   RUNNING....."
Get(L•)
Get(L,)
Get(L,,)
```

Get(L𝑓
ClrHome
Disp "TEMP. [A] IN L•"
Disp "TEMP. [B] IN L,"
Disp "TIME. [T] IN L𝑓"
Disp "TEMP. [C] IN L,,"
Disp "   "
Disp " [PRESS ENTER]"
Pause
ClrHome
Disp " TO SELECT"
Disp "   A GRAPH"
Disp "   "
Disp "   "
Disp " [PRESS ENTER]"
Pause
ClrDraw
ClrHome
Lbl B
Lbl F
Menu("   GRAPHS   ","GRAPH A",U,"GRAPH B",V,"GRAPH C",W,"GRAPHS A,B,
C",Z,"RUN AGAIN",N,"REG. EQ.",Á,"MORE",M)
Pause
Lbl M
Menu("   GRAPHS TWO   ","SAVE",E,"RECOVER",G,"QUIT",O)
Pause
Lbl E
L•üáA
L,üáB
L𝑓üáC
L,,üáD
SetUpEditor áA,áB,áC,áD
ClrHome
ClrDraw
Disp "   "
Disp "   "
Disp " YOUR DATA IS"
Disp " STORED IN LISTS"
Disp " A,B,C, and D"
Disp "   "
Disp " PRESS[ENTER]"
Pause
ClrHome
ClrDraw
Disp "   "

```
Disp "TO RECOVER DATA"
Disp "RUN THE PROGRAM"
Disp "CALLED [RECOVER]"
Disp "     "
Disp " PRESS [ENTER]"
Pause
SetUpEditor
Goto F
Lbl G
áAüL•
áBüL,
áCüLƒ
áDüL,,
ClrHome
ClrDraw
SetUpEditor
Disp "   "
Disp "YOUR DATA IS NOW"
Disp "STORED IN LISTS"
Disp "L• ,L,,Lƒ, and L,,"
Disp "    "
Disp "  PRESS[ENTER]"
Pause
Goto F
Lbl U
ClrHome
ClrDraw
AxesOn
PlotsOff
Plot1(xyLine,Lƒ,L•,Ò)
ZoomStat
Text(52,18,"TIME(SEC)")
Text(15,2,"T")
Text(23,2,"E")
Text(31,2,"M")
Text(39,2,"P")
Text(47,2,"Fô")
Text(5,50,"TO CONTINUE")
Text(15,50,"PRESS ENTER")
Text(25,60,"TWICE")
Trace
Pause
Goto H
Lbl V
ClrDraw
```

```
ClrHome
AxesOn
PlotsOff
Plot2(xyLine,L𝑓,L,,Ò)
ZoomStat
Text(52,18,"TIME(SEC)")
Text(15,2,"T")
Text(23,2,"E")
Text(31,2,"M")
Text(39,2,"P")
Text(47,2,"Fô")
Text(5,50,"TO CONTINUE")
Text(15,50,"PRESS ENTER")
Text(25,60,"TWICE")
Trace
Pause
Goto H
Lbl W
ClrDraw
ClrHome
AxesOn
PlotsOff
Plot3(xyLine,L𝑓,L,,,Ò)
ZoomStat
Text(52,18,"TIME(SEC)")
Text(15,2,"T")
Text(23,2,"E")
Text(31,2,"M")
Text(39,2,"P")
Text(47,2,"Fô")
Text(5,50,"TO CONTINUE")
Text(15,50,"PRESS ENTER")
Text(25,60,"TWICE")
Trace
Pause
Goto H
Lbl Z
ClrDraw
ClrHome
AxesOn
PlotsOn
Plot1(xyLine,L𝑓,L•,Ò)
Plot2(xyLine,L𝑓,L,,Ñ)
Plot3(xyLine,L𝑓,L,,,Ð)
ZoomStat
```

```
Text(52,18,"TIME(SEC)")
Text(15,2,"T")
Text(23,2,"E")
Text(31,2,"M")
Text(39,2,"P")
Text(47,2,"Fô")
Text(5,50,"TO CONTINUE")
Text(15,50,"PRESS ENTER")
Text(25,60,"TWICE")
Trace
Pause
Goto H
Lbl H
Menu("SELECT","NEW GRAPH",F,"REG. EQ.",Á,"QUIT",O)
Lbl Á
ú2üXmin
150üXmax
1üXscl
90üYmin
120üYmax
1üYscl
Menu("REG. EQ.","GRAPH A",1,"GRAPH B",2,"GRAPH C",3,"GRAPH
MENU",F,"QUIT",O)
Lbl 1
Fix 4
AxesOn
FnOff
PlotsOff
ClrHome
ClrDraw
Disp "      "
Disp "      "
Disp "      "
Disp "   RUNNING...."
Plot1(xyLine,L𝑓,L•,Ò)
ExpReg L𝑓,L•,Y•
ZoomStat
aüA
büB
DrawF Y•
Text(52,18,"TIME(SEC)")
Text(15,2,"T")
Text(23,2,"E")
Text(31,2,"M")
Text(39,2,"P")
```

```
Text(47,2,"Fô")
Text(5,50,"TO CONTINUE")
Text(15,50,"PRESS ENTER")
Text(25,60,"TWICE")
Trace
Pause
Goto Á
Lbl 2
Fix 4
AxesOn
FnOff
PlotsOff
ClrHome
ClrDraw
Disp "        "
Disp "        "
Disp "        "
Disp "   RUNNING...."
Plot2(xyLine,Lƒ,L,,Ò)
ExpReg Lƒ,L,,Y,
ZoomStat
aüC
büD
DrawF Y,
Text(52,18,"TIME(SEC)")
Text(15,2,"T")
Text(23,2,"E")
Text(31,2,"M")
Text(39,2,"P")
Text(47,2,"Fô")
Text(5,50,"TO CONTINUE")
Text(15,50,"PRESS ENTER")
Text(25,60,"TWICE")
Trace
Pause
Goto Á
Lbl 3
Fix 4
AxesOn
FnOff
PlotsOff
ClrHome
ClrDraw
Disp "        "
Disp "        "
```

```
Disp "        "
Disp "   RUNNING...."
Plot3(xyLine,Lƒ,L,,,Ò)
ExpReg Lƒ,L,,,Yƒ
ZoomStat
aüE
büF
Text(52,18,"TIME(SEC)")
Text(15,2,"T")
Text(23,2,"E")
Text(31,2,"M")
Text(39,2,"P")
Text(47,2,"Fô")
Text(5,50,"TO CONTINUE")
Text(15,50,"PRESS ENTER")
Text(25,60,"TWICE")
Trace
Pause
Goto Á
Lbl O
ClrDraw
ClrHome
Disp "        "
Disp "        "
Disp "        "
Disp "   GOODBYE"
Stop
```